NBTI/PBTI analysis of the memory characteristics improved by hydrogen annealing in MANOS capacitors

H. D. Kim¹, H-M. An¹, Y. J. Seo¹, Y. Zhang¹, K. C. Kim¹, K. H. Nam², H. B. Chung² and T. G. Kim¹

¹Dept. of Electronics Eng., Korea Univ., Seoul 136-701, Korea
²Dept. of Electronic Materials Engineering, Kwangwoon Univ., Seoul 139–701, Korea

We report the effect of hydrogen annealing on the gate leakage current and switching characteristics of metal-alumina-nitride-oxide-silicon (MANOS) capacitors by analyzing their negative/positive bias temperature instability (NBTI/PBTI). One sample, A, is annealed with rapid thermal annealing (RTA), and the other sample, B, is first annealed with RTA and then further annealed in a furnace, using a N₂-H₂ (2-% hydrogen and 98-% nitrogen) gas mixture. In the NBTI/PBTI experiments, the flat-band voltage shift, $\triangle V_{FB}$, is observed to be smaller; that is, the gate leakage current is reduced, for sample B at gate voltages less than ±3 V, a domain where trap-assisted tunneling is dominant. However, the $\triangle V_{FB}$ increases rapidly for the same sample at gate voltages larger than ±6 V, a domain where the modified Fowler-Nordheim tunneling (MFNT) is dominant, which indicates faster program and erase characteristics. These results show that additional hydrogen annealing can improve both device reliability and switching characteristics of the MANOS-type memory, by reducing interface traps between the silicon substrate and silicon oxide layers as well as turn-on voltages for MFNT.